North Carolina Department of Agriculture and Consumer Services
N.C. Forest Service

Steven W. Troxler
Commissioner

Wib L. Owen
Assistant Commissioner
State Forester

Hurricane Irene
Timber Damage Summary

Prepared By Jason Moan
Forest Health Monitoring Coordinator

On August 27, 2011, Hurricane Irene passed through eastern North Carolina. This category 1 storm made landfall slightly east of Cape Lookout and headed north, passing just west of Lake Mattamuskeet and east of Columbia before crossing Currituck County and exiting the state. This storm caused widespread devastation and flooding along it's path and a survey was conducted to assess the damage to the timber resources of the impacted areas.

Two North Carolina Forest Service (NCFS) - Forest Health Branch aerial survey teams took part in the damage surveys, with aircraft and pilots provided through the NCFS Region 1 office in Kinston. Surveyors and pilots were as follows: Plane 9 Pilot Ricky Hill, Plane 33 Pilot Robert Delleo, Surveyors Jason Moan, Ryan Blaedow, Wayne Langston, and Craig Lawing. The surveys were conducted on August 29th and 30th.

Due to the expansive geographical extent of the storm damage, a ground survey could not be completed in a timely and safe manner. Instead, the damage appraisal to determine the amount of forest damage caused by the storm was completed exclusively using aerial survey data.

General Observations

Overall, the damage to the timber resources of North Carolina as a result of Hurricane Irene appeared as low severity widely scattered uprooted trees and broken stems, with some areas of moderate damage observed near the direct path of the storm. Many large broken and/or uprooted trees were observed in residential and urban areas as well, though this damage was not specifically tracked during this survey. In addition, trees in areas immediately adjacent to the coast showed signs of saltwater damage. Damage to

forest stands as a result of the storm-related flooding may occur in the future, but was not assessable at the time of our survey.

Methods

An aerial survey was completed over the course of two days by Aviation Branch Forest Health Branch staff. In anticipation of the flight, a set of 10 minute grid points were created for the state. Once the storm data could be gathered, grid points that were in the area identified by the National Weather Service as having experienced hurricane-force winds were selected for use in the survey. The selected point dataset contained 82 points scattered across 19 eastern North Carolina counties. Due to the number of points and their geographic spread, the survey was split into a north section and a south section. On August 29, the two survey crews began the surveys. The south crew was able to complete the majority of their points on the 29th, but heavy haze and looming thunderstorms in the northeast corner of the state limited the north crew. As much of the southern survey area had been covered on the 29th, the crews were consolidated and one crew finished the survey on August 30th.

At each pre-determined grid point, each surveyor assessed the average timber damage visible from their side of the plane and marked a point with an appropriate damage class and general stand characteristics. The damage classes were based on the observation of recently windthrown (or toppled) trees, broken main stems, and/or severely damaged crowns and were quantified as follows: Light 1-25%, Moderate 25-50%, Heavy 50-75%, and Severe 75-100% of timber damaged. Additional points were marked as needed to best represent the extent of timber damage. Every effort was made not to mark previously dead standing trees that had been knocked down by the storm.

A total of 216 points were mapped in the 19 counties, with the point damage class percentages represented as follows: 73% - No visible damage, 21% - Light damage, 5% Moderate damage, and < 1% Heavy damage. Using these point data in a GIS analysis, an estimated number of affected acres was calculated and the average value of timber damaged was calculated. This was done by factoring *Timber Mart-South* (Harris, 2011) published values of standing timber for the affected area of North Carolina with volumes obtained from U. S. Forest Service survey information (Brown, 2002). Timber values used were $158.00 per thousand board feet (MBF) International rule for pine sawtimber, $107.00 per MBF for hardwood sawtimber, $17.69 per cord for pine pulpwood and $12.45 per cord for hardwood pulpwood.

The average values per acre were multiplied by midpoint damage levels for each damage class and the resultant figures were multiplied by the acreage in that damage class to obtain volume and value of damage for that class. Midpoint damage levels used in the "Light Damage" class was 13%, in the "Moderate Damage" class damage 37.5%, in the "Heavy Damage" class damage 62.5%, and in the "Severe Damage" class 87.5%. Damages obtained for each damage class were then totaled to obtain total county and District-wide losses.

Results - Based on our preliminary survey, an estimated total of 287,335 acres of timber in 18 counties (See Table 1) sustained some level of damage, with nearly 89% of the damaged acres being classified as light damage. The value of the timber damaged across all affected counties was estimated at $79,674,269 (See Table 2). Visual observations from the survey concluded that nearly 45% of the damage occurred in hardwood stands, 31% in mixed pine and hardwood stands, and 24% in pine stands. The damage occurred across all topographic positions on the landscape, though roughly 64% of the mapped damage occurred in bottomland forests. A map of the damaged areas follows the summary tables.

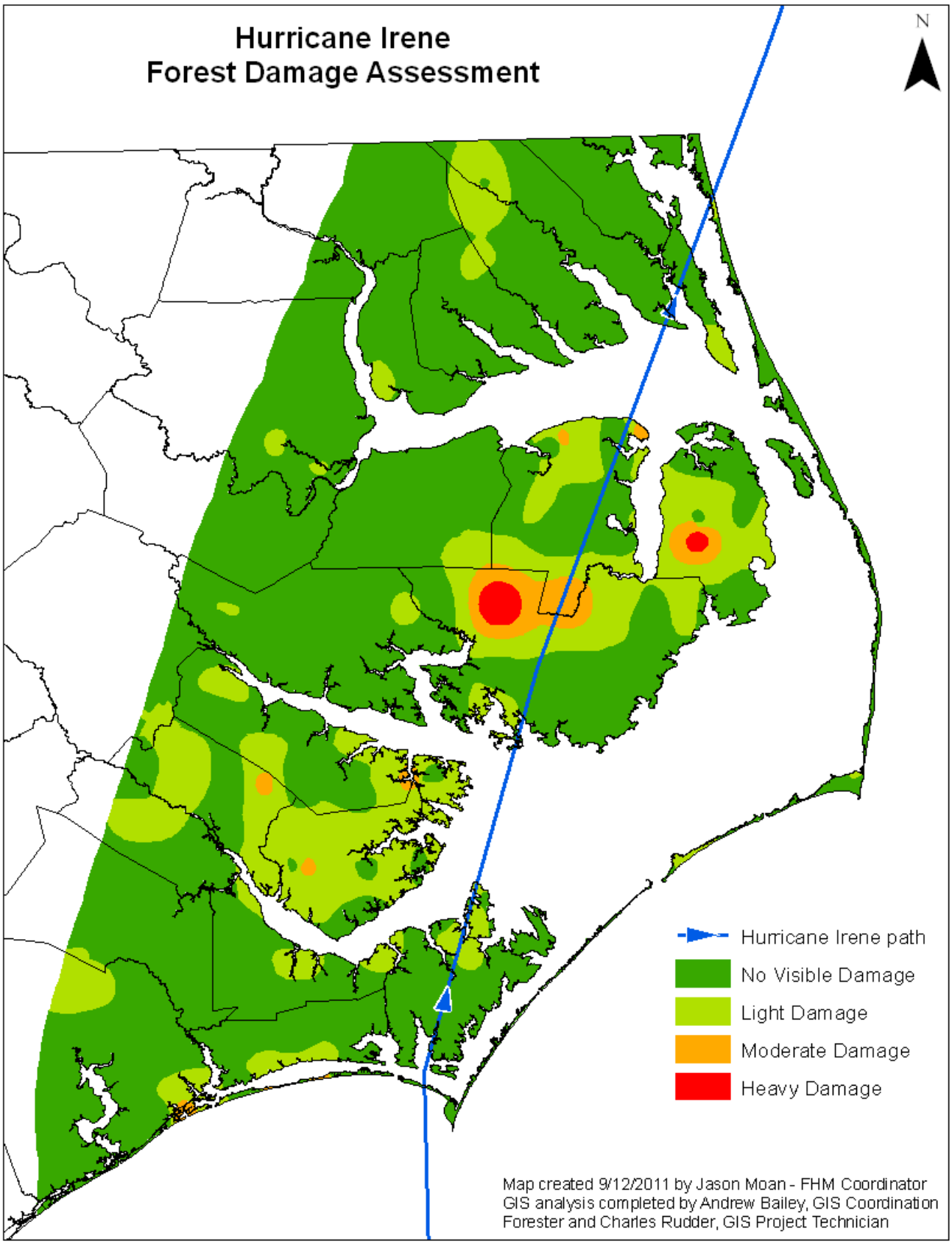
TABLE 1
Acreage of Timberland Damaged in North Carolina
By Percentage Class and County
Hurricane Irene
8/29/2011 & 8/30/2011

County	Damage Class (% Timberland Acres Damaged)				
	1-25	25-50	51-75	76-100	Total
Beaufort	21,932	532	-	-	22,464
Bertie	3,410	-	-	-	3,410
Camden	5,996	-	-	-	5,996
Carteret	10,196	211	-	-	10,406
Chowan	2,212	-	-	-	2,212
Craven	47,881	1,256	-	-	49,137
Currituck	1,276	-	-	-	1,276
Dare	32,097	6,045	1,487	-	39,629
Gates	910	-	-	-	910
Hyde	32,501	11,315	4,549	-	48,366
Jones	1,659	-	-	-	1,659
Onslow	12,525	720	-	-	13,245
Pamlico	40,799	875	-	-	41,674
Pasquotank	6,030	-	-	-	6,030
Perquimans	2,304	-	-	-	2,304
Pitt	2,419	-	-	-	2,419
Tyrrell	26,232	5,985	-	-	32,218
Washington	3,896	85	-	-	3,980
TOTAL	254,274	27,025	6,036	-	287,335

Numbers in rows and columns may not sum to totals due to rounding
A dash (-) indicates no observations were made in county using this sampling method

TABLE 2
Volume and Value of Timber Damaged in North Carolina
By County
Hurricane Irene
8/29/2011 & 8/30/2011

County	Pulpwood Volume Cords	Sawtimber Volume MBF (Int. Rule)	Value Dollars
Beaufort	40,855	31,971	$ 5,640,535
Bertie	7,015	4,245	$ 681,370
Camden	53,308	8,058	$ 1,742,796
Carteret	16,902	15,093	$ 2,726,957
Chowan	3,649	1,449	$ 272,026
Craven	87,252	76,963	$ 13,156,478
Currituck	2,590	2,348	$ 417,474
Dare	79,963	53,518	$ 9,816,799
Gates	2,192	1,392	$ 222,550
Hyde	160,853	93,146	$ 16,834,830
Jones	3,278	1,851	$ 345,856
Onslow	27,978	15,879	$ 2,707,862
Pamlico	82,384	69,751	$ 12,378,245
Pasquotank	10,393	6,176	$ 936,620
Perquimans	6,857	3,613	$ 618,002
Pitt	3,556	3,420	$ 499,199
Tyrrell	75,384	53,392	$ 9,697,055
Washington	6,914	5,535	$ 979,616
Total	**671,324**	**447,800**	**$ 79,674,269**


Hurricane Irene
Forest Damage Assessment
N
Hurricane Irene path
No Visible Damage
Light Damage
Moderate Damage
Heavy Damage
Map created 9/12/2011 by Jason Moan - FHM Coordinator
GIS analysis completed by Andrew Bailey, GIS Coordination Forester and Charles Rudder, GIS Project Technician

Survey Limitations

Survey Method

Usually, storm damage surveys are completed with a combination of aerial reconnaissance and ground survey plots. Completing this survey using only aerial sampling can lead to a some variability due to flight conditions (turbulence, visibility, flight speed and altitude) affecting observer interpretation of ground occurrences. Every effort was made to keep sampling as systematic as possible to minimize biases and variability. The survey extent provides an estimate of damage for only those areas within the hurricane-force wind zone. Damage may be present outside of this area, but the survey was flown under the assumption that the bulk of the damage would be in the area of hurricane-force winds.

Acreage, Volume, and Value

The acreage and volume figures used in this were calculated using assumptions and data from Forest Inventory and Analysis sources. Use of this data to determine acres, volume, and value estimates can lead to unacceptably high sampling error at the county level**.** Additionally, on the western edge of the survey area some counties were only surveyed in part, which could contribute to error in valuation calculations.

Literature Cited

Brown, Mark, 2002. Forest statistics for North Carolina, 2002. USDA Forest Service, Southern Research Station. Resource Bulletin SRS-88. 78 pages.

Harris, Thomas G., Jr., 2011. Timber Mart South. Second Quarter, 2011. Daniel B. Warnell School of Forestry, Univ. Of Georgia, Athens, Ga.

Acknowledgements

The North Carolina Forest Service acknowledges and wants to thank personnel from the Forest Health Branch and Aviation Branch for assisting with the aerial survey and the GIS staff for assistance with post-flight data processing.

Pilots:	Ricky Hill, Robert Delleo
Surveyors:	Jason Moan, Forest Health Monitoring Coordinator
	Ryan Blaedow, Forest Health Specialist - East
	Wayne Langston, Forest Health Technician - East

	Craig Lawing, Forest Health Technician - West
GIS:	Andrew Bailey, GIS Coordination Forester
	Charles Rudder, GIS Project Technician